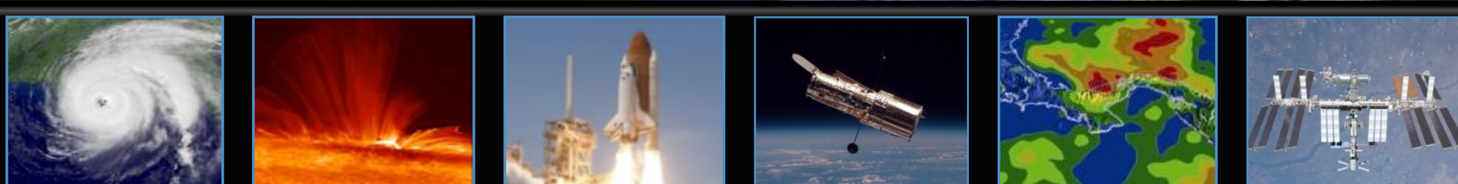
National Aeronautics and Space Administration

Space Launch System

NASA's Space Launch System: State of the Rocket

Todd A. May, Manager
Space Launch System Program
NASA Marshall Space Flight Center
March 20, 2012



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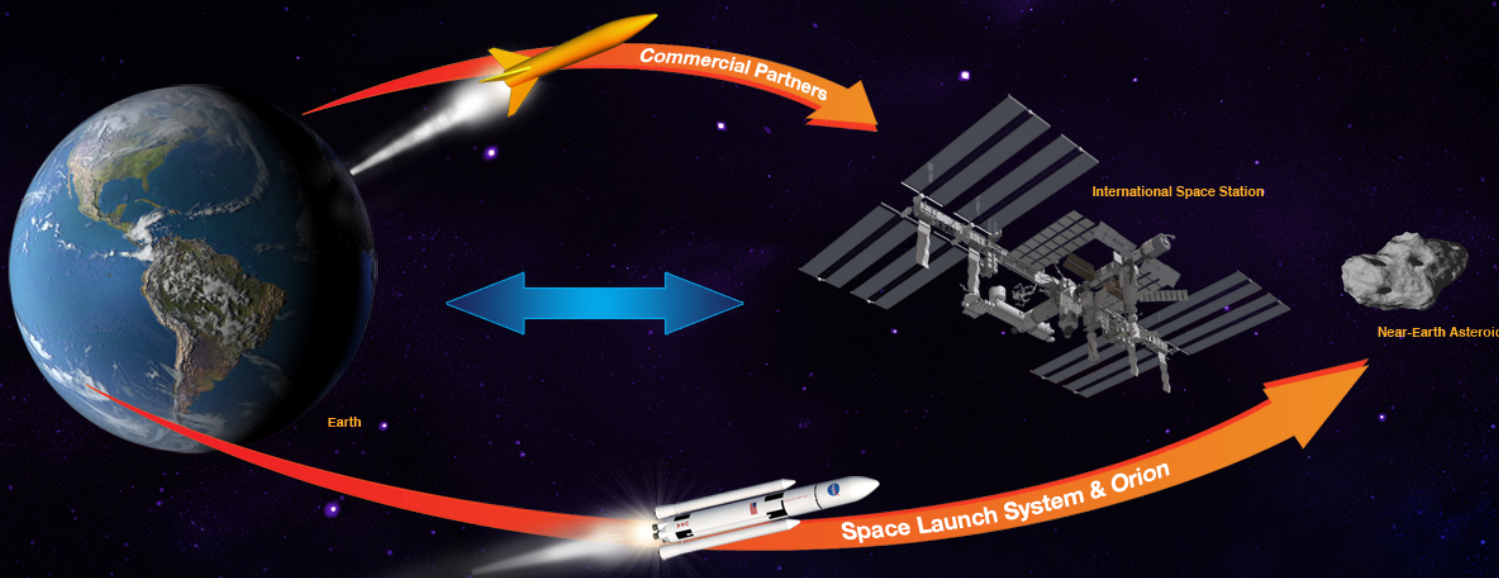
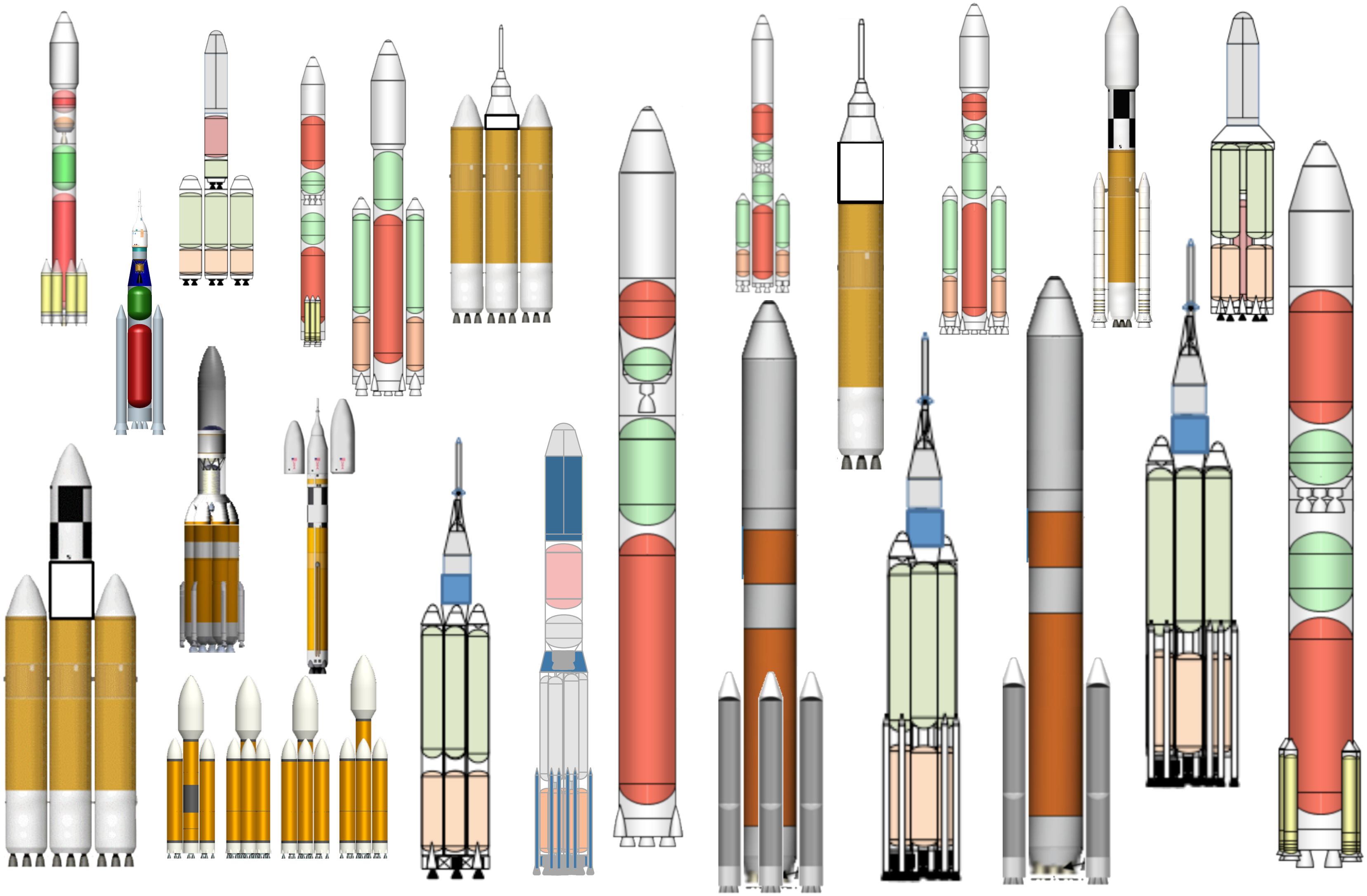
The Future of Exploration



My desire is to work more closely with the human spaceflight program so we can take advantage of synergy…. We think of the SLS as the human spaceflight program, but it could be hugely enabling for science.

— John Grunsfeld, Associate Administrator
NASA Science Mission Directorate
Nature, Jan 19, 2012

Many Solutions, One Affordable Answer



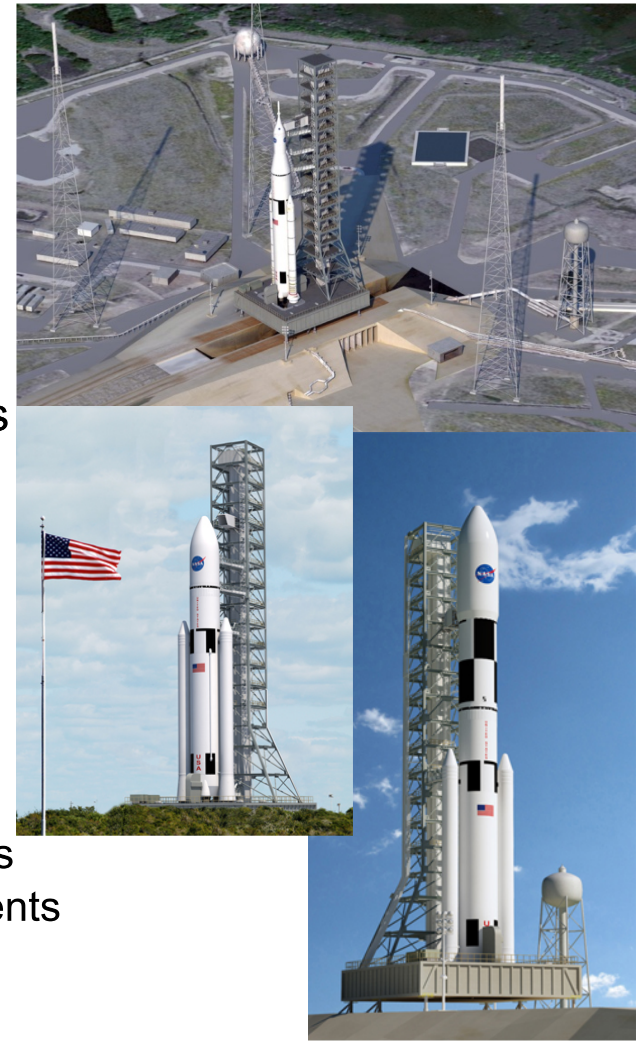
“This enterprise is not for the faint of heart.”
—Wayne Hale, *former Space Shuttle Program Manager*

SLS Driving Objectives

- **Safe: Human-Rated**

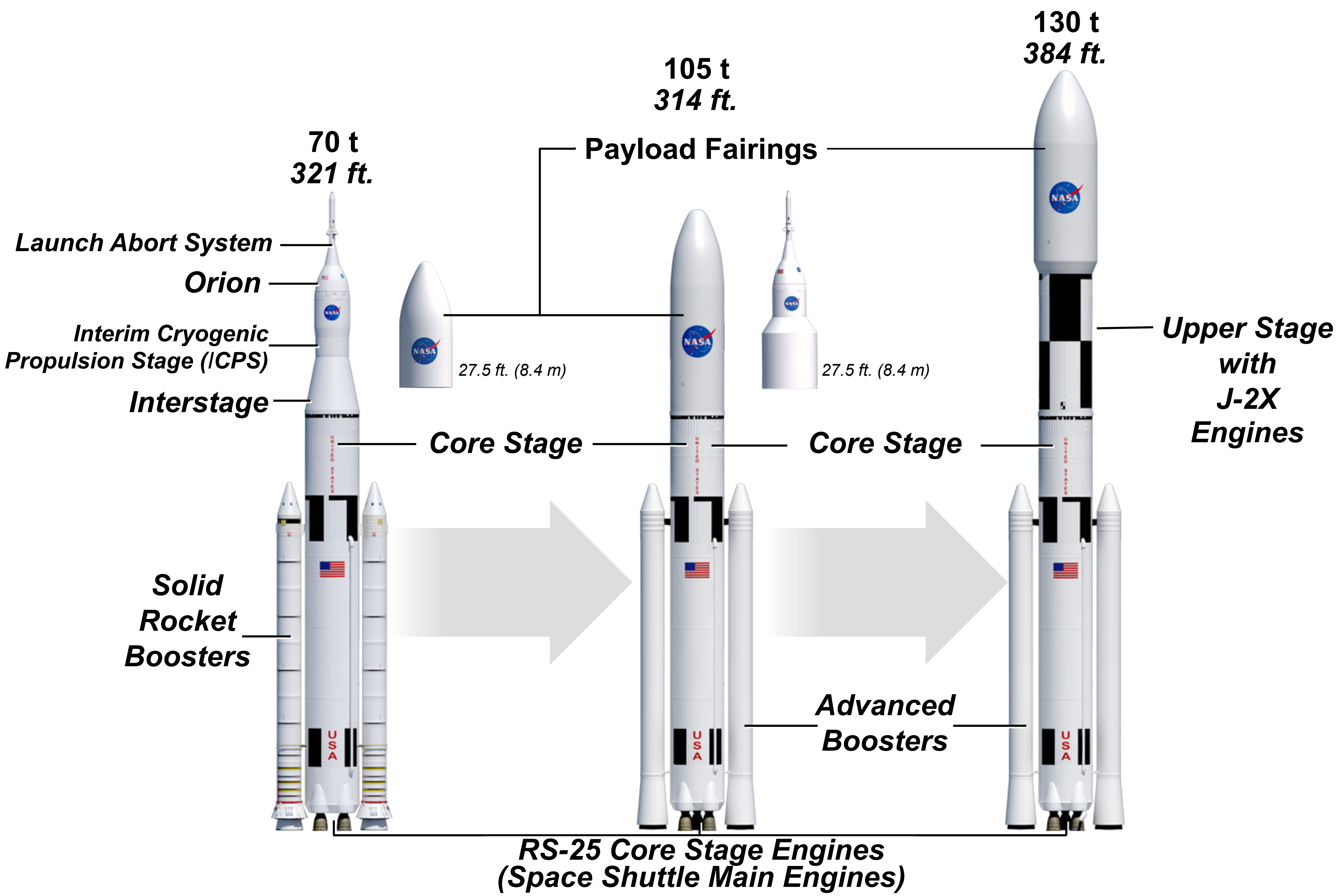
- **Affordable**
  - Constrained budget environment
  - Maximum use of common elements and existing assets, infrastructure, and workforce
  - Competitive opportunities for affordability on-ramps

- **Sustainable**
  - Initial capability: 70 metric tons (t), 2017–2021
    - Serves as primary transportation for Orion and exploration missions
    - Provides back-up capability for crew/cargo to ISS
  - Evolved capability: 105 t and 130 t, post–2021
    - Offers large volume for science missions and payloads
    - Modular and flexible, right-sized for mission requirements



Flexible Architecture Configured for the Mission

SLS Architecture Block Upgrade Approach

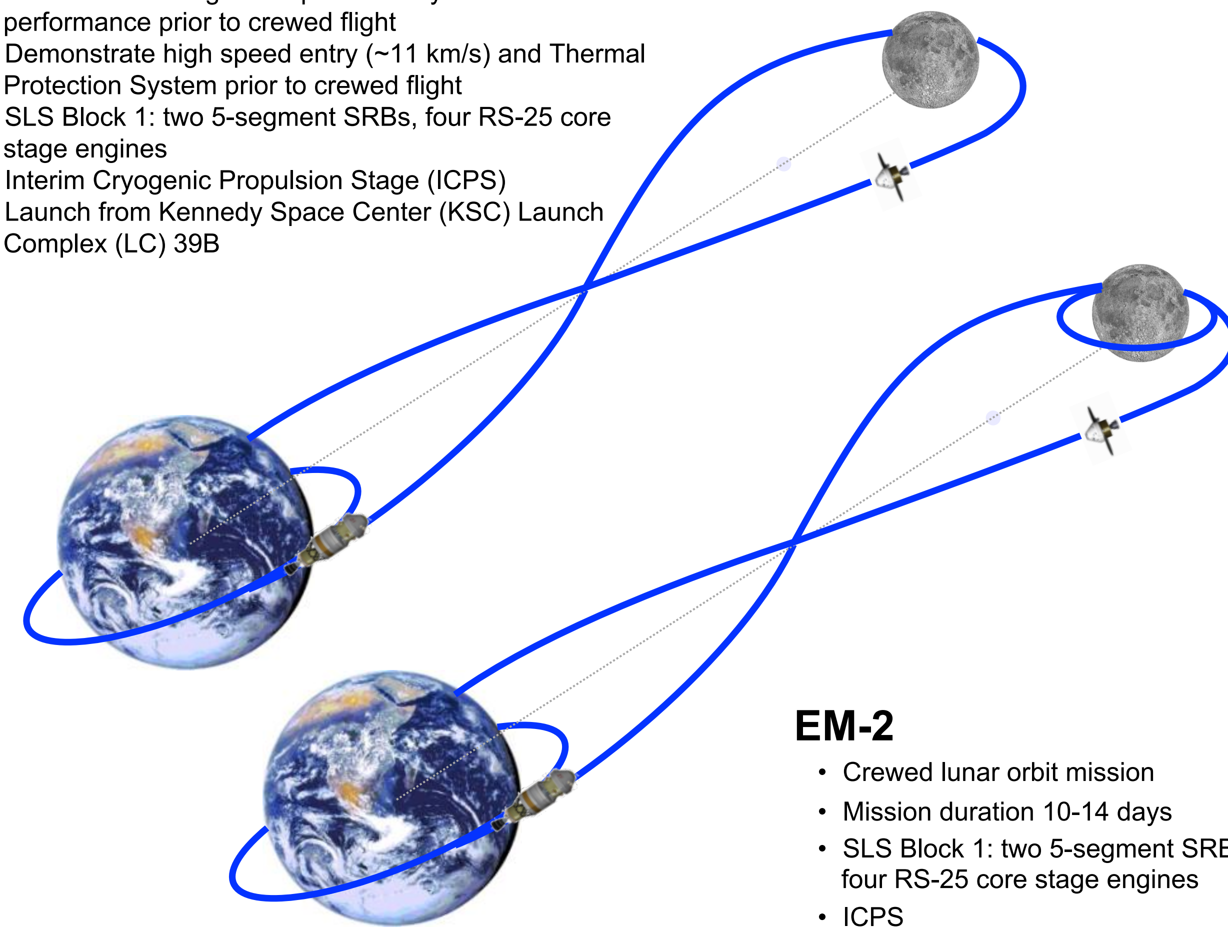


Starting with Available Assets and Evolving the Design

Initial Exploration Missions (EM)

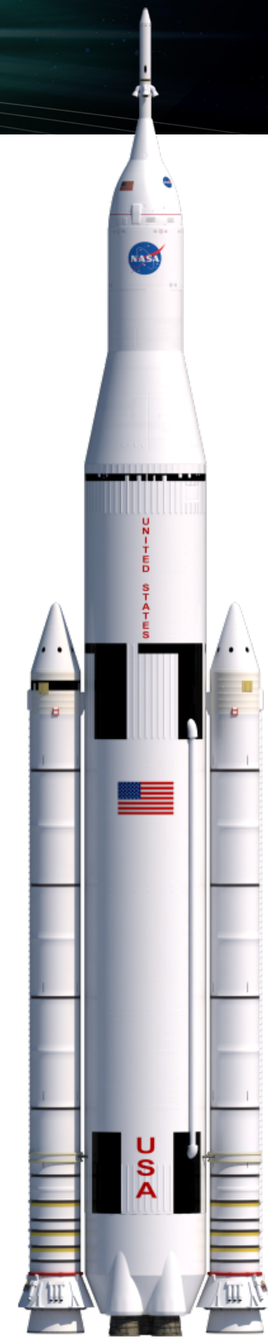
EM-1

- Un-crewed circumlunar flight – free return trajectory
- Mission duration ~7 days
- Demonstrate integrated spacecraft systems performance prior to crewed flight
- Demonstrate high speed entry (~11 km/s) and Thermal Protection System prior to crewed flight
- SLS Block 1: two 5-segment SRBs, four RS-25 core stage engines
- Interim Cryogenic Propulsion Stage (ICPS)
- Launch from Kennedy Space Center (KSC) Launch Complex (LC) 39B



EM-2

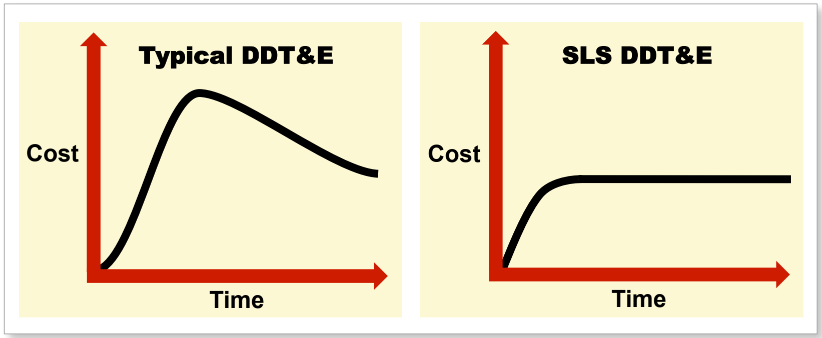
- Crewed lunar orbit mission
- Mission duration 10-14 days
- SLS Block 1: two 5-segment SRBs, four RS-25 core stage engines
- ICPS
- KSC LC 39B

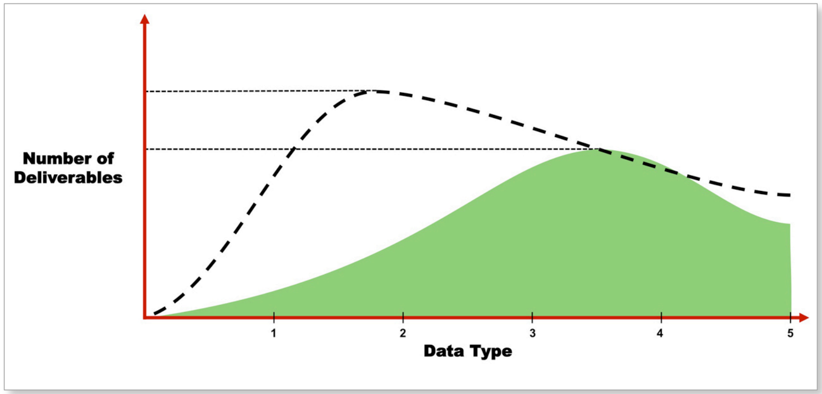


SLS Program Organization at MSFC
NASA
030212
Marshall Workforce Supporting SLS
Other 14%
Operations 40%
Development 46%
Ares
Shuttle
Other Support
A Learning Organization Dedicated to Doing Things Differently
Program Manager Todd May
Deputy Manager Jody Singer
Associate Program Manager Jerry Cook
Assistant Program Manager Sharon Cobb
Hard line programmatic
Matrix relationship
Chief Engineer (CE) Garry Lyles
Deputy CE Danny Davis
Program Planning & Control Acting Manager Jerry Cook
Deputy Manager Daryl Woods
Strategic Development Manager Steve Creech
Chief Safety Officer (CSO) Rick Burt
Deputy CSO Dan Mullane
Procurement Manager Earl Pendley
Boosters Manager Alex Priskos
Deputy Manager Bruce Tiller
Engines Manager Mike Kynard
Deputy Manager Sheryl Kittredge
Stages Manager Tony Lavoie
Deputy Manager John Honeycutt
Ground Operations Liaison Manager Brian Matisak
Assistant Manager Andy Warren
Advanced Development Office Manager Fred Bickley
Assistant Manager Tim Flores
Spacecraft & Payload Integration Manager David Beaman
Assistant Manager Craig McArthur
www.nasa.gov/sls
8155_Marshall Association.7

SLS Affordability Begins with Accountability

- Evolvable Development Approach
- Robust Designs and Margins
- Risk-Informed Government Insight/Oversight Model
- Right-Sized Documentation and Standards
- Lean, Integrated Teams with Accelerated Decision Making





Focuses on the Data Content and Access to the Data

Affordability: The ability to develop and operate the SLS within the National means, to sustain funding for the Program

Assets in Inventory and Testing in Progress

First Flight 2017

Stages Element Progress

Completed Orbiter Vehicle (OV) 103 Main Propulsion System Hardware Removal

- Orbiter hardware reuse study concluded significant cost and schedule savings.
- OV-103, OV-104, and OV-105 hardware removal in process.

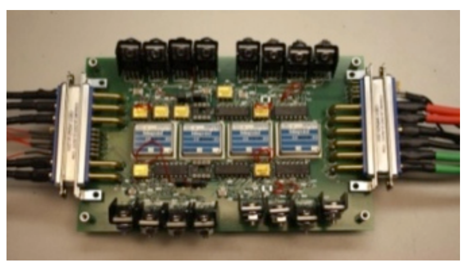
Trust Vector Control Auxiliary Power Unit

E3 LO2 Prevalve & Strong-back Ground Support Equipment

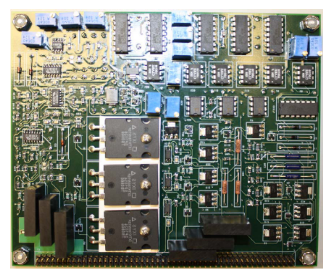
PV9 8” Fill & Drain Valve

Avionics Developments

- Completed early prototype design and development for high-risk items

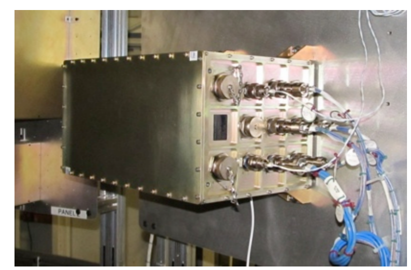


PTS Prototype



3 Channel RPC Prototype

- **Fabricated and demonstrated Power Transfer Switch (PTS) and Remote Power Controller (RPC) prototypes in April 2011.**
- **Completed long-cable test simulating Mobile Launch Equipment in Nov 2011.**

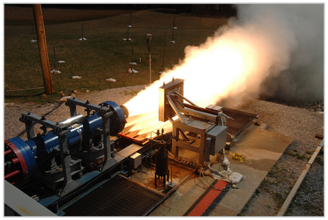


Redundant Inertial Navigation Unit

- **Completed initial integration with flight software.**

Booster Element Progress

- **Sub-Scale Solid Motor 20-Sec Test-Firing**
  - Low-cost replica (9-ft long, 2-ft dia) of SLS solid rocket motor
  - Hot-fired at Marshall on March 14 to test new motor insulation materials

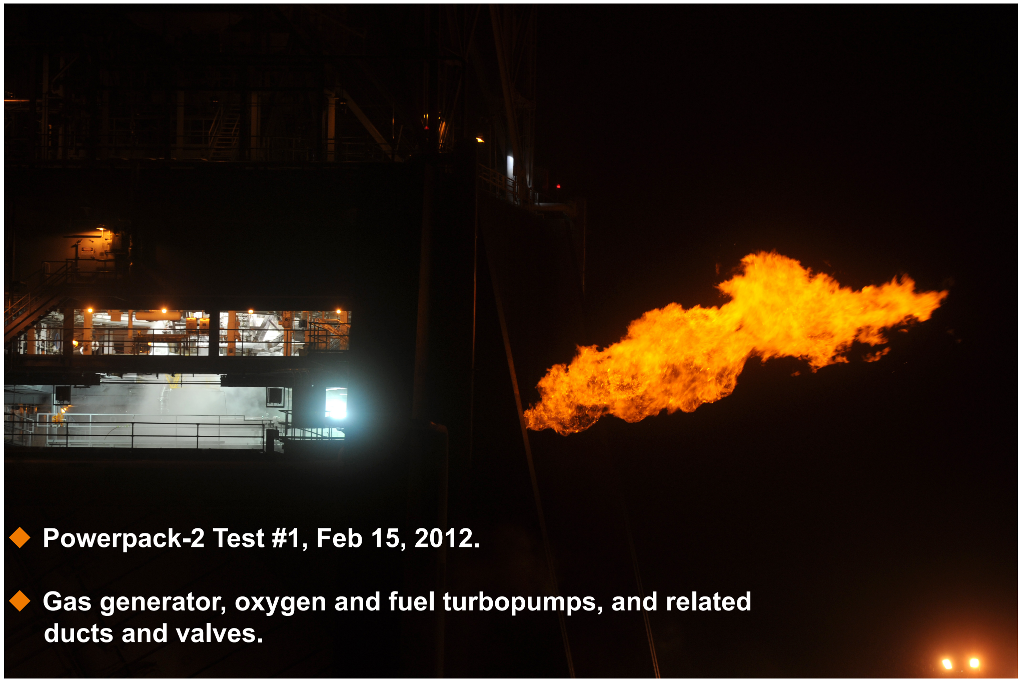


- **Value Stream Mapping (VSM)**
  - 46% cycle-time improvement (308 sources of waste and 447 moves eliminated)
- **Qualification Readiness Review (QRR)**
  - Major motor components (case, propellant, liner, insulator, nozzle, final assembly) to establish the motor's baseline
  - Nozzle QRR and final assembly scheduled for April 10
- **Qualification Motor-1 (QM-1)**
  - Static test scheduled for Spring 2013

- **Booster Requirements Review (BRR)**
  - Scheduled for June 2012
- **Booster Avionics Flight Control Test 1**
  - Scheduled for March 29
  - Full-scale hot-fire test of new avionics boxes controlling the thrust vector control system within a flight-like aft skirt
- **Development Motor-3 (DM-3) Static Test**
  - Successfully conducted on Sept 8, 2011, at ATK

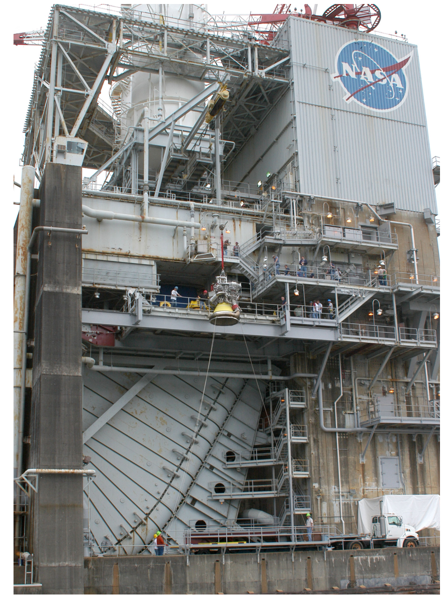
DM-3 Static Test

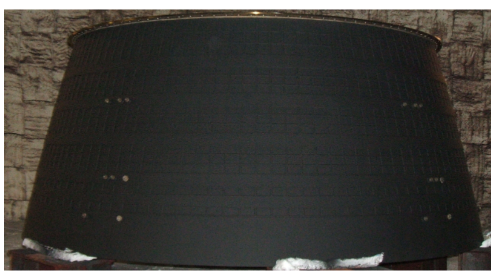
Liquid Engines Element Progress



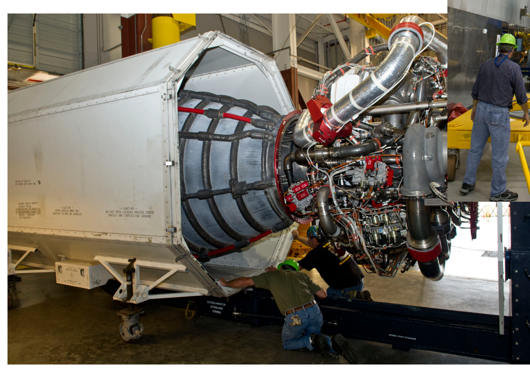
- Powerpack-2 Test #1, Feb 15, 2012.
- Gas generator, oxygen and fuel turbopumps, and related ducts and valves.

- Reinstalling E10001 in A-2 test stand at Stennis Space Center (SSC).
- Preparing for second engine test series.





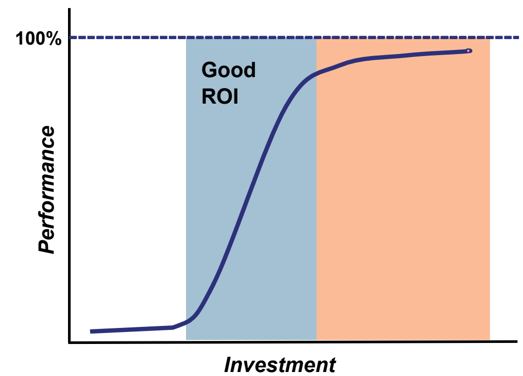
- E10001 Nozzle Extension for second test engine series in A-2 test stand at SSC.



Transporting RS-25 core stage engines from Kennedy Space Center to storage at SSC.

Cost is a Function of Performance

- Extreme requirements drive up costs by 215%.
- Question: Is a 14% increase in maximum speed (performance) *worth* a 215% increase in cost?
- Question: Is a 28% increase in 0 – 60 mph acceleration (performance) *worth* a 215% increase in cost?



Porsche 911 Carrera

Cylinders	6
Engine layout	Rear
Performance	180 mph
0-60 mph	4.7 sec
MSRP	$77,800

Horsepower 345

Porsche 911 Turbo

Cylinders	6
Engine layout	Rear
Performance	195 mph
0-60 mph	3.5 sec
MSRP	$160,700

Horsepower 530

Porsche 911 GT2 RS

— Source: Porsche website

Cylinders	6
Engine layout	Rear
Performance	205 mph
0-60 mph	3.4 sec
MSRP	$245,000

Horsepower 620

We Will Factor the Real Cost into Our Decisions

The *Real* Cost of Launch Vehicle Development

- Affordability requirements demand that we develop the SLS in a faster and more efficient manner, including the decision-making process.

- We cannot afford to delay decisions … or delay getting behind them!

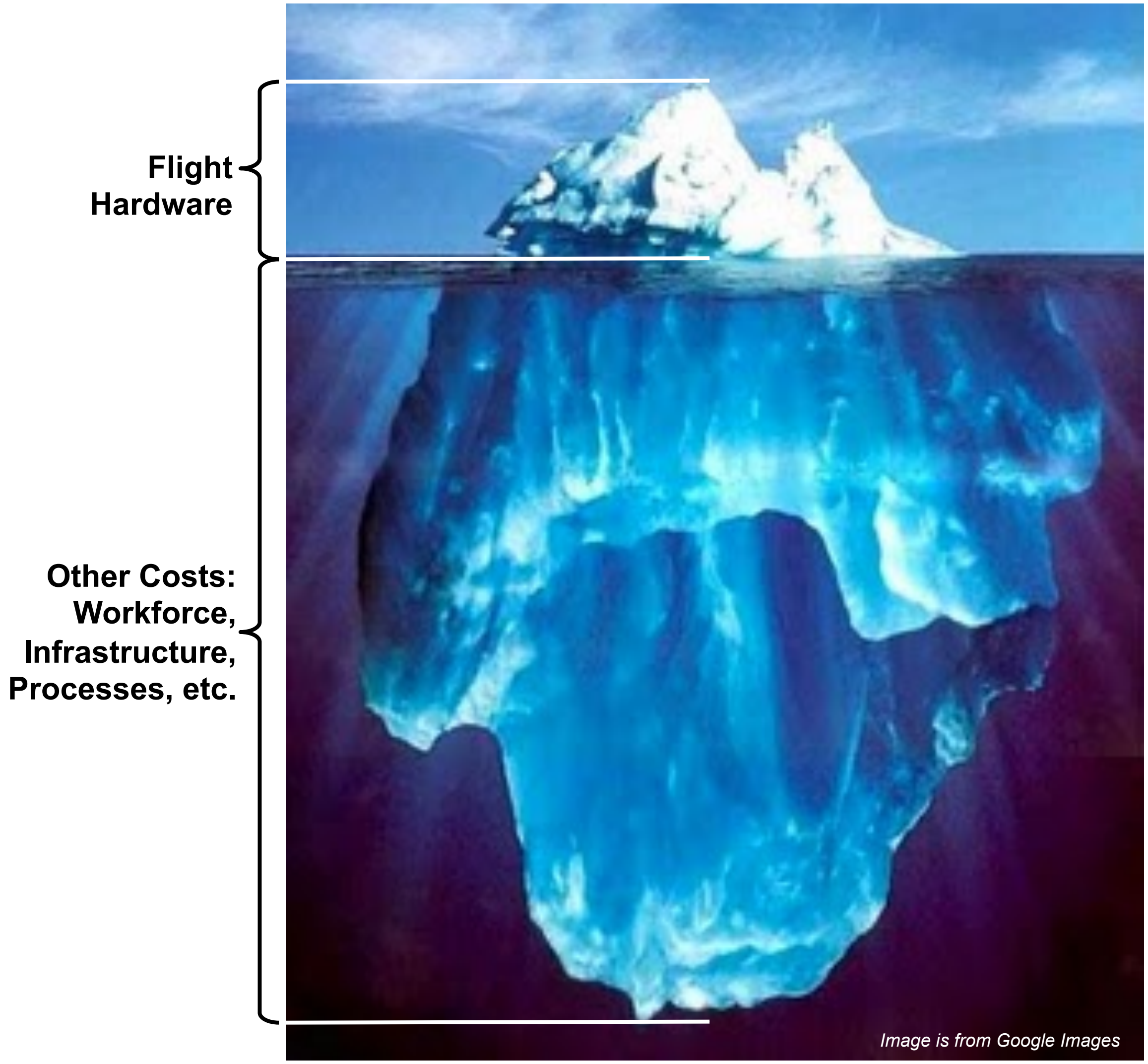


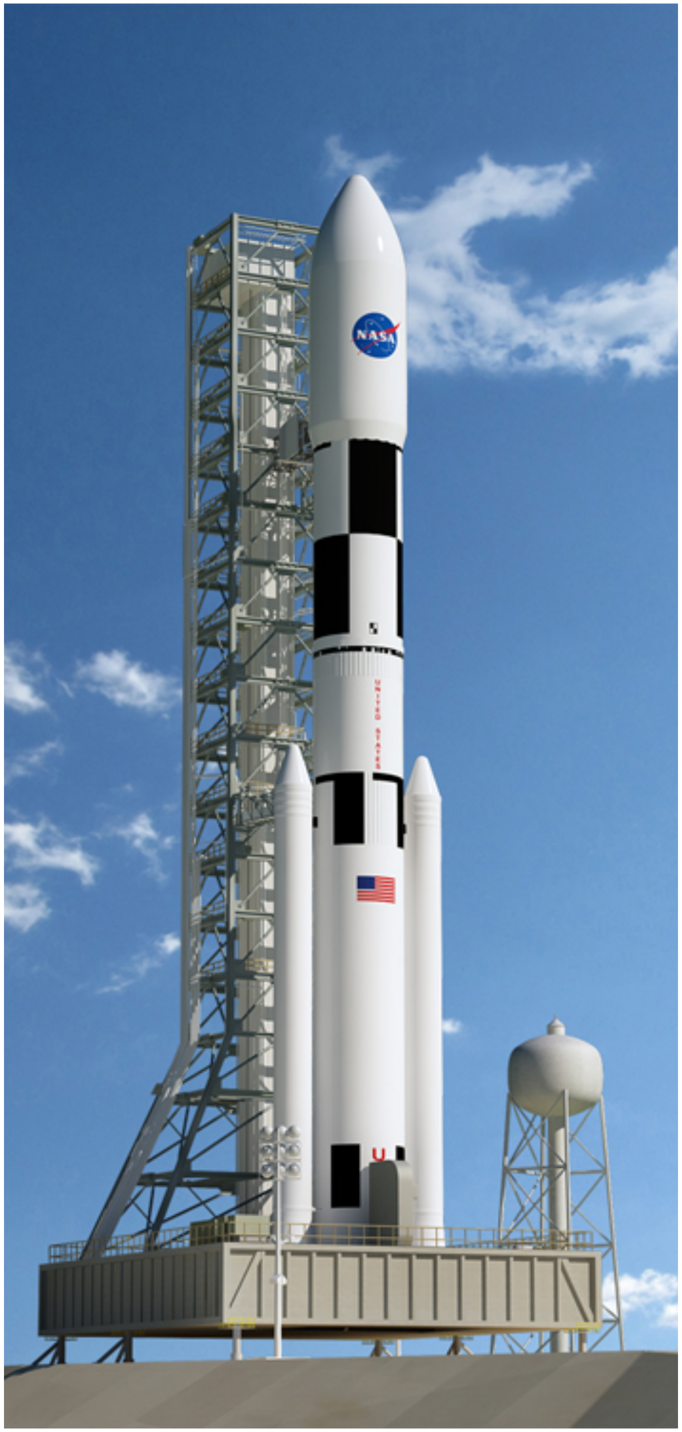
Image is from Google Images

Time Is The One Resource That We Can Never Regain

NASA's Space Launch System Summary

- Vital to NASA's exploration strategy and the Nation's space agenda.
- Key tenets: safety, affordability, and sustainability
- System Requirements Review/System Definition Review in progress.
- Partnerships with Exploration Systems Development (HQ), Orion and Ground Operations Programs, and Centers.
- Prime contractors on board, engaging the U.S. aerospace workforce and infrastructure.
- RS-25 core stage engines positioned for integration and testing with the core stage.
- Five-segment solid rocket booster and J-2X upper stage engine testing in progress.
- Competitive opportunities for innovations that affordably upgrade performance.
- On track for first flight in 2017.

For More Information



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Somewhere, something incredible
is waiting to be known.
— Carl Sagan